KATHMANDU UNIVERSITY
End Semester Examination
July/August, 2024

Marks Scored:

Level : B.Sc.
Year : III

Course : COMP 314
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date 30 JUL 2024

SECTION "A"

[20 Q. × 0.5 = 10 marks]

Choose and mark [X] in the most appropriate option from each set of choices

1. What is the average case running time of an insertion sort algorithm?
[ ] O(N) [ ] O(N log N) [ ] O(log N) [ ] $O(N^2)$

2. What is the time complexity of the brute force algorithm used to solve the Knapsack problem?
[ ] O(n) [ ] O(n!) [ ] $O(2^n)$ [ ] $O(n^3)$

3. Which of the following is NOT a solution for 5-Queen problem?
[ ] (4, 2, 5, 3, 1) [ ] (3, 5, 2, 4, 1) [ ] (1, 4, 2, 5, 3) [ ] (3, 5, 2, 1, 4)

4. To which of the following class does a Traveling salesman problem belong?
[ ] NP class [ ] P class [ ] NP complete [ ] NP hard

5. What does Maximum flow problem involve?
[ ] finding a flow between source and sink that is maximum
[ ] finding a flow between source and sink that is minimum
[ ] finding the shortest path between source and sink
[ ] computing a minimum spanning tree

6. LCS between 11010101101 and 1010101110 is
[ ] 10101010 [ ] 101010111 [ ] 1010100 [ ] 1101010110

7. The running time of Prim's algorithm is _____
[ ] $O((V+E)^2 \log V)$ [ ] O(V log V) [ ] O (E log V) [ ] $O(V^2)$

8. A problem Q is NP-complete if and only if
[ ] Q is NP-hard
[ ] Q is NP and NP-hard
[ ] Q is NP
[ ] Q is P and NP

9. Divide and conquer approach has drawback of _____ over iterative counterpart.
[ ] algorithmic clarity
[ ] space consumption
[ ] time consumption
[ ] both time and space consumption

10. The total time of Ford-Fulkerson algorithm is _____.
[ ] O(V.E) [ ] O(|f| (V+E)) [ ] O(E.F) [ ] $O(V^2)$

11. What is the worst-case time complexity of inserting into a binary search tree of n nodes?
[ ] O(1) [ ] O(log n) [ ] O(n) [ ] O(n log n)

12. It is a generalization of Dijkstra's algorithm that cuts down on the size of the subgraph that must be explored using _____."

[ ] Depth-first search
[ ] Breadth-first search
[ ] Heuristic function
[ ] Dynamic programming

13. Given 5 items of value 12, 32, 40, 50, 20 and weight 3, 8, 2, 6, 1 respectively, if we put these items in a knapsack of capacity 10, what will be the maximum total value in the knapsack?

[ ] 110 [ ] 164 [ ] 92 [ ] 120

14. The running time of quick sort depends on _____

[ ] Number of input
[ ] Number of passes
[ ] Selection of pivot element
[ ] Arrangement of the elements

15. Which of the following approaches tries all possibilities until results are satisfactory?

[ ] Dynamic programming
[ ] Greedy approach
[ ] Divide-and-conquer
[ ] Brute force

16. Which one is **CORRECT** for line number 5 for the given algorithm?

```
MST-KRUSKAL(G, w)
1  A = ∅
2  for each vertex v ∈ G.V
3      MAKE-SET(v)
4  create a single list of the edges in G.E
5  sort the list of edges into monotonically increasing order by weight w
6  for each edge (u, v) taken from the sorted list in order
7      if FIND-SET(u) ≠ FIND-SET(v)
8          A = A ∪ {(u, v)}
9          UNION(u, v)
10 return A
```

[ ] Line 5 : O (| E |)
[ ] Line 5 : O (| E × V |)
[ ] Line 5 : O (| V |)
[ ] Line 5 : O (| V^2 |)

17. Choose the **CORRECT** statement.

[ ] Branch-and-bound is more efficient than backtracking.
[ ] Branch-and-bound is not suitable where greedy approach is not applicable.
[ ] Backtracking divides a problem into at least 2 new restricted sub problems.
[ ] Branch-and-bound divides a problem into at least 2 new restricted sub problems.

18. Which of the following is **NOT** an application of BFS?

[ ] GPS navigation systems: Finding the direction to reach from one place to another
[ ] Solving problems with only one solution, such as maze.
[ ] Finding the shortest path to another node
[ ] Social networks: Find people within a given distance 'k' from a person

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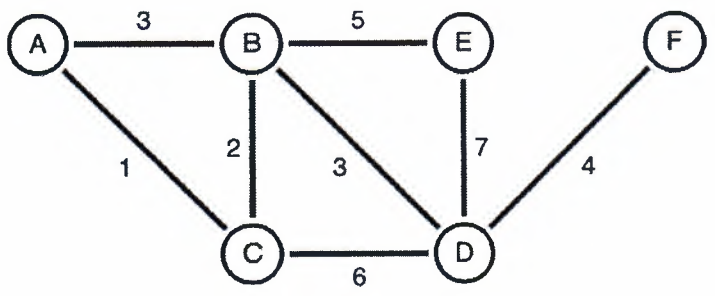
19. Select the **CORRECT** statement for line number 2 of the given algorithm
RECURSIVE-ACTIVITY-SELECTOR(s, f, k, n)

```
1  m = k + 1
2  ____________________________________
3      m = m + 1
4  if m ≤ n
5      return {a_m} ∪ RECURSIVE-ACTIVITY-SELECTOR(s, f, m, n)
6  else return ∅
```

[ ] *while* $m \leq n$ *and* $s[m] < f[k]$
[ ] *while* $m \geq n$ *and* $s[m] < s[k]$
[ ] *while* $m \leq n$ *and* $s[m] > f[k]$
[ ] *while* $m \leq n$ *and* $s[m] < s[k]$

20. What is the total weight of the minimum spanning tree of the given graph?



[ ] 10 [ ] 13 [ ] 15 [ ] 18

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SECTION "B"
[6Q. × 4 = 24 marks]

Attempt *ANY SIX* questions.

1. Provide pseudocode for sorting an array using insertion sort. Explain the role of loop invariants in ensuring the correctness of the insertion sort algorithm. [4]

2. How do backtracking and branch-and-bound differ in terms of their approach to solving problems? [4]

3. How does a binary tree-based parallel prefix sum differ from a sequential prefix sum? [2+2]

4. How do the balancing techniques of AVL trees and Red-Black trees differ? Illustrate with suitable example. [4]

5. How can a greedy approach solve the Activity Selection problem? Apply Activity Selection problem in following list of activities: [1+3]

Activities	A1	A2	A3	A4	A5	A6
Start Time	2	1	0	1	3	4
End Time	5	3	3	2	6	7

6. Write down the Dijstra's shortest path algorithm and analysis it. [4]

7. Write short notes on (Any Two) [2+2]
   a. Master Theorem
   b. Las Vegas algorithms
   c. Fibonacci heap

SECTION "C"
[2Q.× 8 = 16 marks]

Attempt ANY TWO questions.

8. a. How can you formulate a recursive solution for the matrix chain multiplication problem, and how does it work? [3]

   b. Compute the optimal costs for given matrices: [5]
   A_1 of dimension 5 x 4
   A_2 of dimension 4 x 6
   A_3 of dimension 6 x 2
   A_4 of dimension 2 x 7
   Dimensions sequence = $\langle 5, 4, 6, 2, 7 \rangle$

P.T.O.

9. a. What is the Ford-Fulkerson method, and how does it solve the maximum flow problem? [4]

b. Analysis the max-heapify based on best case and worst-case time complexity. [4]

10. a. How can proof by induction be used to prove the correctness of Quick Sort? [3]

b. How does the reduction from 3SAT to the 0/1 Knapsack problem illustrate the concept of polynomial-time reductions? [5]